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CLASSIFICATION OF MARINE TRIAS.

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INTRODUCTION.

THE Triassic system took its name from the peculiar threefold development in the Germanic basin, in which at the base are beds of sandstone, in the middle are massive and shaly limestones, and at the top, clay shales and thin beds of quartzite. This basin was an interior sea, wholly cut off from the outside world during the greater part of its existence; but its sediments are so accessible to students of European stratigraphy that its local names have been used to designate subdivisions of the Trias all over the world. And ever since the extension of local names became customary, geologists have been sorely puzzled to know how to identify the pelagic equivalents of Buntsandstone, Muschelkalk and Keuper, since those inland deposits never contain any of the open-sea species.

Instead of being the type of the Trias, the Germanic basin sediments are the exception, and the type is to be sought in strata that were laid down along the borders of open seas. These have long been known in the limestones and shales of the Alps, Himalayas, Salt Range, Siberia, and western America, but the nomenclature has always been obscured by local names without meaning except to the man that gave them. There is, therefore, an urgent need for some uniform system of nomenclature by which Triassic open-sea sediments may be correlated directly with each other, without reference to the old and unrecognizable divisions.

Quite recently the Vienna geologists, Dr. E. von Mojsisovics, Dr. W. Waagen, and Dr. C. Diener, have attempted to give the desired classification, in a paper entitled: "Entwurf einer Gliederung der pelagischen Sedimente des Trias-Systems,"[1] The authors divide the Triassic pelagic deposits into four series, Scythic, Dinaric, Tirolic, and Bajuvaric; and these again into stages and substages, and further into zones, the latter having usually only a local value. The present paper is based largely on the classification of Mojsisovics, Waagen, and Diener, and is intended to show the relations of American marine strata to those of the European and Asiatic regions; the accompanying correlation table is adapted from that of the same authors, as is also the nomenclature of the subdivisions.

Geography of the Trias. The principal regions where Triassic faunas are known are the Alpine province, the Himalayas and Salt Range, northern Siberia, and western America. The faunas of these countries seem to be so different that they may be taken as representing ancient geographic regions.[2] In Mesozoic times a sea stretched through southern Europe, eastward to the Himalayas; this was years ago called by Neumayr the "Central Mediterranean," and Suess[1] has recently proposed for it the name Thetys.

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[1] Sitzungsber. Kais. Akad. Wissenschaften Wien. Math. Nat. Cl. Bd. CIV., Abth. I. December 1895, pp. 1–32.

[2] Mojsisovics, Arktische Triasfaunen, Mém. Acad. Impér. Sci. St. Petersbourg, VII. Ser. Tome 36, No. 5.

Along the western borders of the Thetys were deposited the Triassic sediments of the Alps, Spain, southern Italy, the Balearic Islands, Sicily, Hungary and the Balkan Peninsula. This region was named by Mojsisovics[2] the Mediterranean Trias province. Most of the faunas of the Trias, from near the base to the top, are represented in this region.

To the east the Thetys spread out to the waters of the Indian region, in which the sediments of the Himalayas and the Salt Range accumulated. The Indian waters joined on the north, east, and south with the great Arctic-Pacific Trias ocean, or Arctis of Mojsisovics, along the borders of which were deposited the sediments of northern and eastern Siberia, Spitzbergen, Japan, Rotti, New Zealand, New Caledonia, Peru, and western North America. But in this ocean region there were many provinces as yet unknown, or only vaguely defined.

The provinces themselves, and even the greater geographic regions, were not constant during the entire Trias, for some of the genera show an entirely different distribution during successive epochs. And even where faunas are common to different regions or provinces they do not always occur at the same horizon. Mojsisovics[3] has shown that during the Lower Trias, or Scythic series, the Mediterranean province was cut off from the Indian and the Arctic-Pacific waters, since it had elements that were lacking in those regions, as *Tirolitinæ*, and lacked many others that were plentiful in the Oriental waters, as *Otoceras*, *Ophiceras*, *Gyronites*, and *Flemingites*. Also many faunal elements that were exceedingly plentiful in the one region were rare in the other. Mojsisovics[4] further noted that during the Dinaric division, or Middle Trias, communication had been opened between the Mediterranean and the Indian regions; thus in the Bosnic substage some faunal elements of the zone of *Ptychites rugifer* are common to both regions. From that time on the Triassic faunas of these two regions show strong resemblances to each other. The connection of the Indian with the Arctic region continued, but was growing less marked.

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[1] Nat. Sci. Vol. II. No. 13, March 1893.

[2] Abhand. K. K. Geol. Reichsanstalt Wien, VI Band, II Haelfte, Das Gebirge um Hallstadt, I Abtheil, II Band, p. 811.

[3] Arktische Triasfaunen, pp. 143–155.

[4] *Loc. cit.*

The writer[1] has demonstrated that the Arctic-Pacific region could hold good only for the Lower Trias, and that during the Upper Trias, Tirolic series, the faunas of California were nearly identical with those of the Himalayan and Alpine provinces, the zone of *Tropites subbullatus* being clearly defined and with nearly identical faunas in all three regions.

Thus in Tirolic time the Arctic-Pacific sea, or Arctis, must have been broken up, and the faunas of the Mediterranean region, or Thetys, must have mingled with those of the great ocean. But that there were other Triassic regions, at present unknown, is seen from the fact that *Tropitidæ* appear suddenly in great numbers and without local ancestors during the Karnic stage of the Upper Trias in both California, India, and the Alpine province. The province where the *Tropitidæ* originated is as yet unknown, but it probably lies outside the Mediterranean, and somewhere within the Arctic-Pacific region.

SUBDIVISIONS OF THE TRIAS.

SCYTHIC SERIES.

Brahmanic stage.—The lowest series of the Trias was named by Waagen and Diener[2] from the region of its most typical development in Asia. It is divided into two stages, the Brahmanic and the Jakutic. The Brahmanic stage is further divided into two substages, an older or Gangetic, and a younger or Gandaric. The Gangetic substage is known only in the Himalayas, where it is represented by the *Otoceras* beds, or zone of *Otoceras woodwardi*, the fauna of which consists chiefly of

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[1] JOURNAL GEOL., Vol. II, No. 4, pp. 375–376.

[2] Entwurf einer Gliederung der pelagischen Sedimente des Trias-Systems, p. 8.

CLASSIFICATION OF MARINE TRIASSIC SEDIMENTS

SERIES	STAGE	SUBSTAGE		ZONE FOSSIL	MEDITERRANEAN REGION	ORIENTAL REGION	ARCTIC-PACIFIC REGI'N	AMERICAN REGION
BAJUVARIC	Rhaetic		22	*Avicula contorta*	Koessen Beds			
	Juvavic	Sevatic	21	*Sirenites argonautæ*	Juvavic Limestone of Hallstadt	Balia Maden in Asia Minor *Halorella* beds of the Pamir	*Monotis* beds of Rotti	*Pseudomonotis* beds of Peru
			20	*Pinacoceras metternichi*				
		Alaunic	19	*Cyrtopleurites bicrenatus*				
		Laciacic	18	*Cladiscites ruber*		Himalayan Juvavic limestone		
			17	*Sagenites giebeli*				Hosselkus limestone
TIROLIC	Karnic	Tuvalic	16	*Tropites subbullatus*	Sandling beds	Himalayan Karnic limestone	*Daonella* beds of Rotti	with *Subbullatus* and *Trachyceras* faunas
		Julic	15	*Trachyceras aonoides*	Raibl beds			
		Cordevolic	14	*Trachyceras aon*	St. Cassian beds			Swearinger slates
	Noric	Longobardic	13	*Protrachyceras archelaus*	Wengen beds		Nipon beds of Japan	Triassic beds of Queen Charlotte Islands
		Fassanic	12	*Dinarites avisianus*	Marmolata beds			Pitt Shales of Shasta Co., California Star Peak beds of Nevada
			11	*Protrachyceras curionii*	Buchenstein beds			
DINARIC	Anisic	Bosnic	10	*Ceratites trinodosus*	Upper Muschelkalk	*Ptychites rugifer* beds of the Himalayas	*Daonella* beds *Posidonomya* beds Spitzbergen Beds of Russkij and Olenek	
		Balatonic	9	*Ceratites binodosus*	Lower Muschelkalk	*Sibirites prahlada* beds of the Himalayas		
	Hydaspic		8	*Stephanites superbus*		Upper *Ceratite* limestone of the Salt Range		
SCYTHIC	Jakutic		7	*Flemingites flemingianus*	Zone of *Tirolites cassianus* Werfen beds of the Tyrolean Alps	*Ceratite* sandstone of the Salt Range *Subrobustus* beds of the Himalayas	Olenek beds of Siberia	*Meekoceras* beds of Idaho ? Santa Ana limestone of California
			6	*Flemingites radiatus*				
			5	*Ceratites normalis*				
	Brahmanic	Gandaric	4	*Proptychites trilobatus*		*Ceratite* marls of the Salt Range	Beds of Ussuri and Russkij	
			3	*Proptychites lawrencianus*		Lower *Ceratite* limestone of the Salt Range		
			2	*Gyronites frequens*				
		Gangetic	1	*Otoceras woodwardi*		*Otoceras* beds of the Himalayas		

Danubites, *Proptychites*, *Prosphingites*, *Koninckites*, *Flemingites*, *Meekoceras*, *Ophiceras*, *Otoceras*, *and Medlicottia*. The two last genera begin in the Permian, but live on into the Trias, *Otoceras* increasing in numbers, and *Medlicottia* becoming scarcer. These beds and their fauna have been described by C. L. Griesbach,[1] and C. Diener.[2] They lie just above the *Productus* shales of the Permian and the sediments grade over gradually from one formation into the other; thus the chasm between the Palæozoic and the Mesozoic is at last bridged over. A complete monograph of this fauna will appear soon in a report by Dr. C. Diener, in Palæontologia Indica, Ser. XV, Vol. II.

The upper or Gandaric substage is represented by marine faunas only in the Salt Range, where it was described by W. Waagen.[3] It comprises the lower Ceratite limestone, and the Ceratite marls. The lower Ceratite limestone is the zone of *Gyronites frequens*, and has a cephalopod fauna consisting of *Dinarites*, *Ambites*, *Proptychites*, *Kymatites*, *Meekoceras*, *Koninckites*, *Lecanites*, *Gyronites*, and *Prionolobus*, all *Leiostraca* but one.

The Ceratite marls comprise two zones, that of *Proptychites lawrencianus* Koninck, and above that of *P. trilobatus* Waagen; their cephalopod fauna consists of *Proptychites*, *Meekoceras*, *Koninckites*, *Gyronites*, *Prionolobus*, *Clypites*, *Ambites*, *Kingites*, and *Danubites*.

The *Proptychites* beds are further represented in the region of the Gulf of Ussuri in eastern Siberia, where they have been described by Dr. C. Diener.[4]

Jakutic stage.—The Jakutic stage is most typically developed in the Salt Range, where it is represented by the Ceratite sandstone, the fauna of which, according to Waagen,[5] consists of

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[1] Palæont. Notes on the Lower Trias of the Himalayas, Records Geol. Survey India, XII, 1880, pp. 94–113.

[2] Denkschr. K. Akad. Wiss. Wien. Bd. LXII, 1895, pp. 571 et seq.

[3] Fossils from the Ceratite Formation. Pal. Indica, Salt Range Fossils, Ser. XIII, Vol. II, 1895.

[4] Triadische Cephalopodenfaunen der ostsibirischen Küstenprovinz. Mèm. Com. Gèol. St. Petersbourg, Vol. XIV, No. 3.

[5] Pal. Indica, Ser. XIII, Salt Range Fossils, Vol. II, 1895.

Kymatites, *Kingites*, *Meekoceras*, *Koninckites*, *Gyronites*, *Paranorites*, *Proptychites*, *Flemingites*, *Parakymatites*, *Aspidites*, *Lecanites*, *Prionolobus*, *Dinarites*, *Ceratites*, *Prionites*, *Celtites* and *Acrochordiceras*.

In the Himalayas the Jakutic stage is represented by the *Subrobustus* beds, whose fauna, as listed by Diener,[1] consists of *Ceratites*, *Danubites*, *Hedenstrœmia*, *Meekoceras*, *Lecanites*, *Aspidites*, *Proptychites*, and *Flemingites*, of species nearly related to, and in some cases identical with, forms known in the Salt Range Ceratite sandstone.

This stage is further known in northern Siberia, near the north of the Olenek River; Mojsisovics[2] has described its fauna, which consists of *Dinarites*, *Ceratites*, *Sibirites*, *Meekoceras*, *Hedenstrœmia*, *Kingites*, *Prosphingites*, *Goniodiscus*, *Popanoceras*, *Pleuronautilus*, and *Atractites*. Two of the most characteristic species, *Hedenstrœmia mojsisovicsi* Diener, and *Ceratites subrobustus* Mojsisovics, are common to the Olenek beds of Siberia, the Ceratite sandstone of the Salt Range, and the *Subrobustus* beds of the Himalayas.

In America the Lower Trias, and probably the Jakutic stage, is represented in the *Meekoceras* beds of the Aspen mountains in southeastern Idaho, the cephalopod fauna of which consists of *Meekoceras gracilitatis* White, *M. aplanatum* White, *M. mushbachianum* White, and *Arcestes*[3] sp? These species are somewhat related to forms from the Ceratite sandstone of the Salt Range, and during Jakutic time the western American seas must have been connected with those of India.

In California there are strata that probably belong to the Jakutic stage; in the Santa Ana Mountains, Orange county, Mr. H. W. Fairbanks found in a massive black limestone fossils that probably indicate Lower Trias. They consisted of *Pseudomonotis* aff. *clarai*, a trachyostracan ammonite, and an undetermined brachiopod, probably *Rhynchonella*. *Pseudomonotis clarai* is diagnostic for the Werfen beds, upper part of Lower Trias, in the

[1] Denkschr. K. Akad. Wiss. Wien., Math. Nat. Cl. Bd. LXII, 1895, pp. 571 et seq.

[2] Arktische Triasfaunen.

[3] 12th. An. Rep. U. S. Geol. Surv. Terr. Part 1, pp. 105–118.

Alps, and its near relative may belong to the same horizon in a different geographic province.

In Shasta county, California, the Pitt formation consists of a series of siliceous shales probably in part of Lower Triassic age, but no fossils have yet been found in that part of the series.[1]

Outside the Arctic-Pacific region the Jakutic stage is represented in the Alpine province by the Werfen beds, zone of *Tirolites cassianus;* this fauna has long been taken as the type of marine Lower Trias, until the rich discoveries in India have shown the comparative poverty of the Alpine fauna. In the Mediterranean region are known in this stage only twenty-five *Cephalopoda* against two hundred and twelve in the Asiatic region.

DINARIC SERIES.

Hydaspic stage.—Faunas of the Hydaspic stage are known with certainty only in the upper Ceratite limestone of the Salt Range,[2] where forty-one species have been described, consisting chiefly of *Dinarites*, *Ceratites*, *Prionites*, *Danubites*, *Celtites*, *Acrochordiceras*, *Stephanites*, *Sibirites*, *Goniodiscus*, *Meekoceras*, *Lecanites*. Thirty-five of these species belong to the *Trachyostraca*, and only six to the *Leiostraca*, a marked contrast to the distribution in the Scythic series.

The *Posidonomya* limestone of Spitzbergen may belong here, if one may judge from the stage of development of the ammonites,[3] as may also the limestone of Chitichun in Thibet, according to Dr. Diener.[4]

Anisic stage.—The type of the Anisic stage is found in the Muschelkalk of the Mediterranean region, where it is divided into a lower substage, Balatonic, zone of *Ceratites binodosus*, and on upper, Bosnic, zone of *C. Trinodosus*. These faunas have been described in many works, but all the species have been summed up by Mojsisovics in "Die Cephalopoden der Mediterranen Triasprovinz,"[1] and later F. von Hauer has described many species from the Muschelkalk of Bosnia,[2] from which this substage takes its name.

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[1] J. P. SMITH, JOUR. GEOL., Vol. II, No. 6, p. 601.

[2] W. WAAGEN, Fossils from the Ceratite Formation, Pal. Indica, Ser. XIII, Salt Range Fossils, Vol. II, 1895.

[3] MOJSISOVICS, Arktische Triasfaunen, p. 152.

[4] Denkschr. K. Akad. Wiss. Wien. Bd. LXII, math. nat. Cl., 1895, p. 596.

In the Himalayas the Balatonic substage is represented by the zone of *Sibirites prahlada*, and the Bosnic division by the zone of *Ptychites rugifer*. In this horizon there are three species common to the Mediterranean and the Indian regions, *Orthoceras* conf. *campanile* Mojsisovics, *Proarcestes balfouri* Oppel, and *Sturia sansovini* Mojsisovics, and other closely related.[3] Certain beds of the Salt Range also belong here, but their fauna is too poor and too little known to be comparable.

In the Asiatic region the Anisic stage is represented on the shores of the Sea of Marmora;[4] further on the Island of Russkij[5] near Wladiwostoc, Siberia; near the mouth of the Olenek River;[6] also, according to Dr. Diener, near the mouth of the Lena.

The *Posidonomya* limestone and the *Daonella* limestone of Spitzbergen, according to Mojsisovics, represent the Dinaric series, the former probably the Hydaspic, and the latter probably the Anisic stage.

F. B. Meek[7] has described from Star Peak, Nevada, a number of Triassic species, part of which, according to Professor A. Hyatt,[8] belong to the Muschelkalk horizon. Waagen and Diener[9] erroneously make Hyatt cite Muschelkalk from Plumas county, California, but Hyatt's remarks referred only to Nevada. There are, however, in California strata probably of

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[1] Abhandl. K. K. Geol. Reichsanstalt Wien. X Band, 1882.

[2] Denksch. K. Akad. Wiss. Wien. Math. Cl. Bd. LIV, 1887, Die Cephalopoden des bosmischen Muschelkalkes von Han-Bulog in Sarajevo; and *ibid*, Bd. LIX, 1892, Beiträge zur Kenntniss der Cephalopoden aus der Trias von Bosnien.

[3] C. Diener, Cephalopoda of the Muschelkalk. Pal. Indica, Ser. XV, Himalayan Fossils, Vol. II, Part 2.

[4] According to the paper by Waagen, Diener and Mojsisovics cited above.

[5] C. Diener, Mém. Com. Geol., St. Petersbourg, Vol. XIV, No. 3.

[6] Mojsisovics, Arktische Triasfaunen.

[7] U. S. Geol. Expl., Fortieth Parallel, Vol. IV.

[8] Bull. Geol. Soc. Am., Vol. III, 1892, p. 400.

[9] Entwurf einer Gliederung der pelagischen Sedimente, etc., p. 26.

Dinaric age. The writer[7] has described a series of shales in Shasta county that have the stratigraphic position of the Muschelkalk, and a few species of fossils not incompatible with that age; they are *Trachyceras?* conf. *whitneyi* Gabb, *Pseudomonotis* sp., and *Proarcestes* sp., and some others not identified. The fossiliferous shales lie about 1500 feet below limestones of Karnic ages, with the fauna of the *Subbullatus* zone, and conformably with them.

[7] JOUR. GEOL., Vol. II, No. 6, p. 602.

TIROLIC SERIES.

Noric stage.—For the Upper Trias the Tyrolean Alps have always furnished the types of marine development; the faunas of this series have been compiled and described by Mojsisovics in "Die Cephalopoden der Mediterranen Triasprovinz," and "Das Gebirge um Hallstadt," although the works of von Hauer, Klipstein, Laube, and others have contributed largely to our knowledge of the fossils.

The Noric stage in its typical development is known only in the Alpine region, where it is divided into the Fassanic and the Longobardic substages; but a somewhat different facies occurs also in Japan,[1] although the substages cannot be recognized.

In North America, too, are found strata probably of Noric age, in British Columbia;[2] in Nevada, where part of the Star Peak section belongs to the Noric;[3] in California where its fauna and stratigraphy have been described by various authors.[4] The reference of the western American beds to the Noric horizon is based chiefly on the occurrence in them of several species of *Monotis* and *Halobia* allied to Noric forms and to the identity of several of the American species with those from Japan.

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[1] MOJSISOVICS, Ueber einige Japanische Triasfossilien. Beitr. Palæont. Oesterreich-Ungarns, etc., Bd. VII.

[2] J. F. WHITEAVES, Contributions to Canadian Palæontology, Vol. I, Part 2, pp. 127–149.

[3] U S. Geol. Expl. Fortieth Parallel, Vol. IV.

[4] W. M. GABB, Palæont., Calif., Vol. I.; A. HYATT, Bull. Geol. Soc. Am., Vol. III., pp. 395–400; J. P. SMITH, JOUR. GEOL., Vol. II., No. 6, pp. 603–606.

Karnic stage.—The Mediterranean region has furnished the type for the Karnic stage, and its fauna has been summed up by Mojsisovics in the two works cited above. In the Alps this stage is divided into a lower or Cordevolic substage, zone of *Trachyceras aon*, represented by the St. Cassian beds; a middle or Julic, zone of *T. anonides*, whose type is the Raibl beds; and an upper or Tuvalic, which is represented by the Sandling beds, the most characteristic fossils of which are *Tropites subbullatus* Hauer, and its near relatives.

Outside the Mediterranean region the Karnic stage is represented in the Himalayas,[1] where characteristic faunas of the Julic and Tuvalic substages occur; probably on the Island of Rotti[2] in the Indian Archipelago; and in California, where its fauna has been described and listed in the same papers that were cited under the Noric stage.

Faunal anomalies.—In the Mediterranean region the lower and middle Karnic substages are characterized by the prevalence of *Trachyceras* and *Protrachyceras* and the absence of *Tropites;* while in the upper Karnic *Trachyceras* and *Protrachyceras* have disappeared, being replaced by *Sirenites;* while *Tropites* and its allies make up a large part of the fauna. This is also true of the Himalayan province, where the *Subbullatus* fauna appears after that of *Trachyceras aon*, and not intermingled with it. In those regions *Trachyceras* does not seem to have left any descendants in upper Karnic time, and *Tropites* and its near allies seem to have no local ancestors, but have migrated in from some region outside the Thetys sea.

In the Karnic beds of California,[3] just at the top of the *Halobia* slates, are found great numbers of *Protrachyceras* and *Sirenites*, associated with *Tropites Subbullatus* Hauer, and numerous other species of *Tropites Bullati*. One of the *Protrachycerata* resembles closely *P. Attila* Mojsisovics, a characteristic form for the middle Karnic, zone of *Trachyceras aon* in the Mediterranean region. The numerous species of *Sirenites* all seem to belong to the group of *Senticosi*, characteristic of middle Karnic; the half dozen or more species of *Paratropites* might belong to either the middle or the upper horizon, as might also the species of *Eutomoceras*. But *Tropites* of the group of *T. Bullati*, and *Sagenites* (*Trachysagenites*), of the group of *S. herbichi* Mojsisovics, are characteristic of upper Karnic. The writer[1] previously called attention to a part of these faunal anomalies, but their full extent was not appreciated at that time.

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[1] C. DIENER, Denksch. K. Akad. Wiss. Wien, math. nat. C. Bd. LXII, 1895.

[2] A. ROTHPLETZ, Perm Trias und Juraformation auf Timor und Rotti, Palæontographica, 39 Band. 1892.

[3] For the stratigraphy of this series see JOURNAL GEOLOGY, Vol. II, No. 6. J. P. SMITH: The Metamorphic Series of Shasta county, California; and Bull. Geol. Soc. Am., Vol. III, A. HYATT, Jura and Trias at Taylorsville.

In the lower part of the Hosselkus limestone of Shasta county, California, there is an undoubted mixture of the middle and upper Karnic faunas. This apparent anomaly might be explained in two ways. Since *Tropites* and its near allies appear as immigrant faunas in the Karnic of the Mediterranean region, the Himalayas and California, it is possible that they may have reached California earlier than they did the other regions, and while the middle Karnic fauna still predominated. Or, on the other hand, it may be that *Protrachyceras* and other members of the *Trachyceras aon* fauna lived on longer in California than in other known regions, so that we have a middle Karnic fauna persisting in upper Karnic time. To the writer it seems more probable that the *Subbullatus* fauna came in earlier, reaching California in middle Karnic time, especially since *Tropites* seems to have been endemic in the Arctic-Pacific region, and since this fauna did not all reach California at the same time, but some came in later. Thus, *Homerites semiglobosus* Hauer, and *Eutomoceras* conf. *quinquepunctatum* Mojsisovics, which in the Alps occur in the zone of *Tropites subbullatus*, in California occur only at a horizon about 150 feet higher, and associated with a fauna that is chiefly different from that of the lower zone. In this higher horizon none of the *Trachyerata* are left, and the cephalopod fauna consists almost entirely of *Tropitidae* and *Arcestidae*, the former being represented by *Eutomoceras*, *Tropites*, *Paratropites*, *Homerites*, and

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[1] JOURNAL GEOLOGY, Vol. III, No. 4, p. 494.

Juvavites. These beds may represent the Tuvalic substage, from the prevalence of *Juvavites* of Tuvalic type, although the zone fossil, *Tropites subbullatus* was not found in this horizon. They may, on the other hand, represent the base of the Juvavic stage, since Professor Hyatt[1] cites from Hosselkus limestone of Plumas county *Rhabdoceras* and *Halorites*, neither of which is known below the Juvavic stage in the Alpine region. It may be, however, that here again we have an immigrant fauna reaching this region earlier than other known regions.

BAJUVARIC SERIES.

The Bajuvaric series is typically developed in the Tyrolean Alps, where it is divided into the Juvavic and Rhætic stages. The fauna of the Juvavic stage has been described by Mojsisovics in "Das Gebirge um Hallstadt," and that of the Rhætic by various authors.

Juvavic faunas have further been described from Asia Minor, Pamir, Afghanistan, the Himalayas, New Caledonia, and Peru.[2] In California the upper part of the Hosselkus limestone may belong to the Juvavic stage, as has already been stated in this paper, since *Rhabdoceras* and *Halorites* occur in it.

The Rhætic is so little known in its marine facies that all attempts to refer foreign marine strata to this horizon have failed. The cephalopod faunas of Rhætic age thus far known are very meager, and there is no way of comparing distant localities with each other.

CONCLUSION.

It can no longer be said that the Alps furnish the typical region even for marine Trias; each region of the earth seems to have some open-sea development of a stage that is lacking elsewhere, and new explorations bring to light each year faunas that were unknown before. Each new discovery holds out to us the possibility of tracing migrations of faunas from one region to another, and thus following their development under new conditions. Thus the necessity of combining studies in faunal geography with those in phylogeny, is self-evident.

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[1] Bull. Geol. Soc. Am. Vol. III, Jura and Trias at Taylorsville.

[2] For the literature of the Juvavic stage see Mojsisovics, Denksch. K. Akad. Wiss Wien. Bd. CIV, Abth. I, p. 30, 31.

JAMES PERRIN SMITH.

STANFORD UNIVERSITY, CALIFORNIA.